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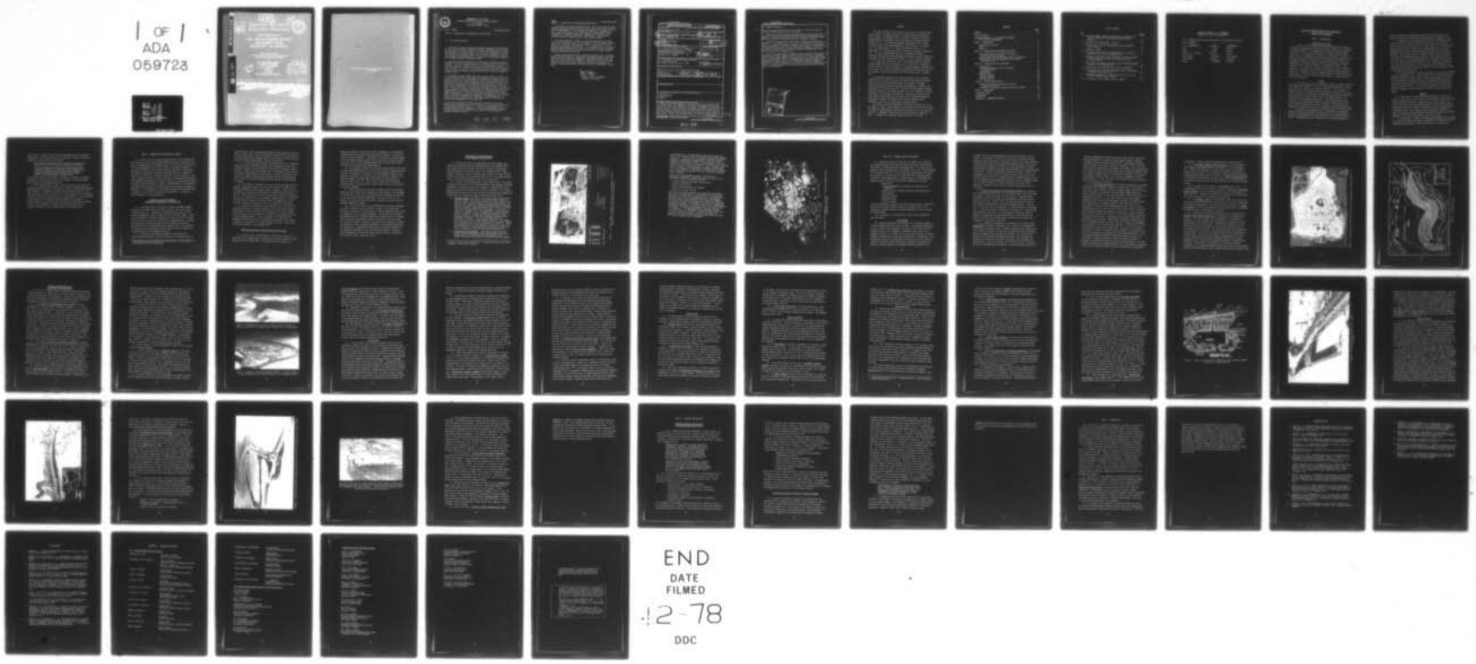

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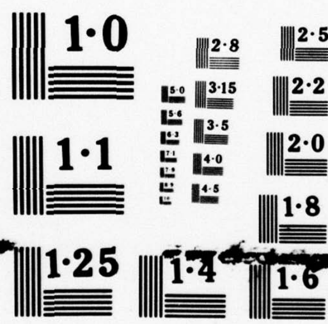

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LEVEL II

DREDGED MATERIAL RESEARCH PROGRAM

MISCELLANEOUS PAPER D-78-4

LAND USE OF DREDGED MATERIAL CONTAINMENT AREAS: PRODUCTIVE USE EXAMPLES

by

Environmental Laboratory
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180

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Portland, Oregon 97204

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August 1978
Final Report

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Prepared for Office, Chief of Engineers, U. S. Army
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Under Contract No. DACW39-76-C-0132
(DMRP Work Unit No. 5D03)

Monitored by Environmental Laboratory
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180

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WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
P. O. BOX 631
VICKSBURG, MISSISSIPPI 39180

IN REPLY REFER TO: WESEV

30 September 1978

SUBJECT: Transmittal of Miscellaneous Paper D-78-4

TO: All Report Recipients

1. The technical report transmitted herewith represents the results of one of several research efforts (work units) undertaken as part of Task 5D, Disposal Area Land Use Concepts, of the Corps of Engineers' Dredged Material Research Program (DMRP). The objective of Task 5D, as part of the Productive Uses Project (PUP), was to obtain information to facilitate planning and implementation of concepts for the ultimate productive use of dredged material containment areas.

2. Because of possible constraints on open-water disposal of dredged material, the Corps of Engineers has had to resort more and more to land disposal. Land for disposal activities is becoming scarce and the problem becomes more acute with the need for selecting each new disposal area. Attention, therefore, can be profitably and justifiably directed towards identifying disposal concepts that enhance rather than degrade available land.

3. Some DMRP work units under other tasks were designed to develop improved disposal facility operations and management procedures as well as develop techniques for the reclamation of potentially valuable materials. Both objectives could increase disposal area life expectancy as well as enhance site aesthetic and environmental characteristics. However, all sites will eventually be filled and the total picture would be incomplete without considering concepts for the productive uses of the created land. To this end, most of the problems associated with the land use of dredged material containment areas relate to a planning rather than an engineering function. This particular research effort was one of five aimed at assessing the economic, technical, environmental, institutional, legal, and social incentives and constraints to the development of a rational basis for candidate site selection, ultimate land use, and postdisposal management of the created land.

4. The specific purpose of this study was to identify and document examples of productive uses of lands created as a by-product of new work or maintenance dredging activities. This report demonstrates that dredged material can be a manageable resource and encourages consideration of productive use concepts by Corps and non-Corps planners of dredging/ disposal projects.

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5. An information survey approach was used. The various examples were obtained from the published literature and project descriptions and from persons knowledgeable in the planning and execution of dredging projects. Forty-four sites in 18 states and six foreign countries were identified and classified into seven categories of productive uses: recreational, industrial/commercial, agricultural, institutional, material transfer, waterway related, and multiple purpose.

6. The study identified a number of planning conditions and actions that can significantly impact on the productive use of disposal-created land forms. Productive land uses are shown to fall within a broad spectrum of complexity and intensity. It is suggested that, in order to achieve greater land intensity, there is a need on the part of project sponsors and developers to recognize and deal with a greater number of planning conditions and actions.

7. The major institutional factor limiting productive uses of dredged material is the division of responsibility between Federal, State, and local governments regarding navigation, environmental protection, and land use. Multi-objective planning is proposed as a means of accommodating these and other vested interests that have the potential to impact on disposal-productive land use concepts for containment facilities.

JOHN L. CANNON
Colonel, Corps of Engineers
Commander and Director

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The study documents examples of productive land uses of dredged material containment areas. The examples were obtained from published literature and project descriptions and discussions with persons knowledgeable in the planning and execution of dredging projects. The examples are from 19 states and six foreign countries. The sites range from those filled over 50 years ago, which have been used productively for many years, to projects in various stages of development. Projects are documented within the following land use categories: cont

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CONT

recreational, industrial/commercial, agricultural, institutional, material transfer, waterway related, and multiple purpose.

Based on the examples cited and information analyzed during the study, the site-selection process is discussed from historical and modern prespectives. Examples of recent processes and approaches to candidate site selection implemented by communities in the United States and abroad are described.

Productive land uses tend to fall within a hierachy of complexity and intensity. It is suggested that this hierachy is accompanied by a need on the part of the sponsor or developer to recognize and deal with a greater number of planning conditions to achieve a greater land use intensity. These planning conditions are interrelated to several identifiable planning actions that, if properly undertaken, can significantly enhance the productive use of the landform created at the disposal site.

Finally, the study draws conclusions concerning the quality and quantity of literature available on productive land uses and the potential for achieving productive land uses on dredged material. Identified as a major institutional factor limiting productive uses of dredged material is the division of reponsibility between Federal, state, and local government regarding navigation, environmental protection, and land use. Multi-objective land use planning is proposed as a means of accommodating these many other vested interests that will impact to varying degrees on the objective of placing dredged material where it can be used productively.

PREFACE

The study described in this report is the result of several information inputs. Foundation material was supplied via work performed under Contract No. DACW39-76-C-0132, entitled "Productive Land Use of Dredged Material Containment Areas: International Literature Review," between the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss., and Beeman/Benkendorf (joint venture) of Portland, Ore. Mr. Ogden Beeman, P.E., Consulting Engineer, and Mr. A. P. Benkendorf, IPA, Planning Consultant, conducted the contract investigation. Extensive supplemental input was provided by MAJ Mark D. Malkasian, WES Research and Development Coordinator, who also edited and organized the final report, and Mr. Robert J. Wills, Research Assistant.

The study was performed as part of the Dredged Material Research Program (DMRP) which was sponsored by the Office, Chief of Engineers, and was conducted under the auspices of the Environmental Laboratory (EL) at the WES. The contract portion was conducted under Work Unit 5D03 of the Productive Uses Project during the period August 1976 to February 1977.

The invaluable assistance of the staff members from 20 Corps of Engineer District Offices who provided project description and shared their ideas concerning productive land use concepts for dredged material containment areas is gratefully acknowledged. Likewise, the cooperation of the representatives of private and governmental organizations who assisted in obtaining information for the furtherance of this investigation is similarly acknowledged. Particularly helpful information from sources abroad was received from the Brisbane (Australia) Department of Harbours and Marine, the Toronto (Canada) Harbour Commission, and the City of Rotterdam, The Netherlands.

The contract work was monitored by MAJ Robert M. Meccia, CE, and Mr. Thomas R. Patin, Project Manager of the Productive Uses Project, WES. The DMRP was performed under the general direction of Dr. John Harrison, Chief, EL. Commander and Director of the WES during the study was COL J. L. Cannon, CE. Technical Director was Mr. F. R. Brown.

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LIST OF FIGURES

CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U. S. customary units used in this report can be converted to metric (SI) as follows:

Multiply	By	To Obtain
feet	0.3048	metres
yards	0.9144	metres
miles (U. S. statute)	1609.344	metres
cubic yards	0.7645549	cubic metres
tons (short)	907.1847	kilograms
acres	0.4046856	hectares

LAND USE OF DREDGED MATERIAL CONTAINMENT AREAS

PRODUCTIVE USE EXAMPLES

PART I: INTRODUCTION

Background and Purpose

1. The U. S. Army Engineer Waterways Experiment Station (WES) is conducting a comprehensive nationwide research program on the disposal of dredged material. The Dredged Material Research Program (DMRP) objective is "to provide more definitive information on the environmental effects of dredging and dredged material disposal operations and to develop technically satisfactory, environmentally compatible, and economically feasible dredging and disposal alternatives, including consideration of dredged material as a manageable resource." The purpose of this study was to identify the productive uses of landfills created as a by-product of new work or maintenance dredging disposal activities. Landfills created by dredging (mining) of selected material (sand, gravel, or shell) for the primary purpose of creating the fill were not considered.

Scope

2. The study was, in part, a literature search to identify national and international examples of locations where dredged material containment areas have resulted in productive land uses. At the outset, it appeared that little information was available on the subject since most of the literature on dredging and dredged material disposal operations in recent years has focused on water quality, biological impacts, and hydraulic and soils engineering aspects. This observation was borne out early in the study when a search of indices, bibliographies, and other pertinent publications failed to identify a significant amount of literature on productive land uses of dredged material containment areas.

3. Recognizing this apparent lack of published source material, persons holding key positions of responsibility for the planning and execution of dredging projects were contacted in the United States and abroad. Dredging projects were identified and are described herein

that have resulted in productive land uses and that demonstrate the variety of land uses possible with dredged material containment areas.

4. Throughout the study, emphasis was placed on containment areas filled with silt and finer grained material because uses for these areas are limited compared to uses for sites filled with coarser grained material such as sand. However, some limited examples of the use of granular material were documented along with those of finer grained material. Any productive uses of dredged material other than landfill were also to be documented during the study. This stipulation led to the inclusion of a use category designated as "waterway related" where the use is more accurately described as a use of material as against a use of the resulting landfill. This study was also restricted to the reporting of wildlife and fisheries productive uses for projects outside the continental United States.

5. The study documents a number and variety of land uses on dredged material containment areas. This information will assist planners and managers representing, among others, public works agencies, state and local governments, regulatory agencies, environmental/conservationist groups, and dredging contractors by indicating the range of land uses that have proven feasible. The study also indicates the factors that appear to enhance the opportunities for productive land uses to take place.

Approach

6. Several tasks were addressed simultaneously to achieve the purpose of the study. The most fruitful task resulted from contact with Corps of Engineers agencies. Communications by phone, letter, and personal visits to Corps Divisions and Districts and the WES uncovered the greatest number and variety of beneficial uses of dredged material containment areas. Also through letters and personal contacts, a number of national and international information sources were solicited. Appendix A lists information sources used in this study.

7. Concurrently, a number of dredging bibliographies were surveyed and several specialized searches were examined for relevant literature. Supplementing this effort, several periodicals and transactions

most likely to contain relevant articles were examined on a volume-by-volume basis for the past 20 years of publication. From the literature examined, two general points are evident:

- Most dredging literature over the years has focused on the mechanical aspects of dredging operations and equipment.
- While the environmental effects of dredging have drawn increased attention in recent years, the literature tends to focus on questions of biological and water-quality impacts rather than productive land uses of dredged material or dredged material disposal sites.

As a result, although the available literature on dredging is growing, relatively little has been written on the subject of productive land uses resulting from dredging activities.

8. The final task was a visit to The Netherlands and England and subsequent discussions with individuals involved in dredging work planning and operations. In addition to identifying productive land uses, the study attempts to provide an insight into the process by which containment areas are converted to productive uses in those countries. Upon completion of these tasks, the following report was compiled that documents notable examples of productive land uses and draws conclusions therefrom on the role of planning as a means of achieving a wide variety of potential productive uses of dredged material containment areas.

PART II: PERSPECTIVES ON PRODUCTIVE LAND USE

9. It will be clear from the examples cited in the following part that there have been a large number and great variety of productive land uses of dredged material containment areas. But not quite so evident is that full development of the future potential for useful purposes is dependent on proper project planning and site selection. Traditionally, the possible approaches to these two functions have been as many and varied as the spectrum of innovative productive uses is unlimited. This report attempts to narrow or limit this number of approaches and identify the planning considerations and actions essential to implementing disposal-productive land use concepts. However, a comprehension of the historical and modern-day perspectives on planning and site-selection processes is essential to the recognition of the framework within which dredged material disposal on land can be successfully accomplished. Following is a brief discussion of those perspectives.

Historical Perspective-Almost Exclusively a Question of Site Selection

10. A national system of ports and navigable waterways emerged during the late 1800's and early 1900's on major rivers and estuaries in the United States. Disposing of dredged material from river and channel deepening and harbor construction was relatively simple. There was an abundance of seemingly nonproductive lands on all river systems, and these lands were close to the source of dredged material. Planners encountered only limited regulatory and institutional constraints governing their use as dredged material disposal sites. The selection of these sites was often made literally onsite by the end donkey man* during the course of the dredging operation.

11. The material was generally viewed as fill material in estuaries where there was a need to create land for constructing port

* Slang term for the man controlling the end donkey or anchor barge at the discharge end of the pipeline.

facilities and to provide permanent deepwater access adjacent to docks built in tidal areas. There are examples in almost every estuarine port in the United States and Europe where port facilities have been built on material dredged during channel or harbor construction.

12. In many areas where material was deposited on low or submerged lands, there was no immediate pressure toward development since there existed an abundance of buildable land with suitable foundation characteristics. These sites often blended into the landscape, and because of the generally high demand and desirability of waterfront property, the sites were ultimately absorbed and developed over the ensuing decades. The fact that they had been dredged material disposal sites was purely incidental.

13. The growth of passenger air service and the attendant need for landing fields turned some of this land into airports as noted in the Hoquiam, Washington, and Portland, Oregon, citations. Other sites, such as Galveston, were devoted to shipyards for shipbuilding during World War II. Today, these older sites are supporting a variety of productive land uses so beneficial to the surrounding community that it is hard to envision what the economic and social fabric of communities such as Portland, or Galveston, would be like in the absence of these lands.

14. However, as valuable as these lands are today, the sites were generally selected by the Corps District or the local project sponsor based mainly on their proximity to the dredging area. This selection process was almost solely based on one factor: the discharge capability of the dredging equipment. This is confirmed in a 1969 article on dredging and disposal practices containing the statement: "The primary consideration in selecting an onshore disposal area is to locate land as close as possible to the dredging work."[1]

Modern Perspective-An Increasing Need for Planning

15. In recent years, identifying the closest area on land or in open water has no longer been an acceptable or practical method to select dredged material disposal areas. Two conditions have evolved: the

general shortage of available lands and the emergence of environmental awareness and concern that further reduce the inventory of land available for material disposal. Urbanization, often sped by the development of older dredged material disposal sites, has taken up available lands. Productive uses on older dredged material sites now have made them unavailable for receiving more dredged material.

16. The buildup of nearby lands, often hastened because of the uses of adjoining dredged material fill areas, has likewise taken these lands from use. Concurrently, awareness of the environmental impact of the decrease in wetlands, water surface area, and productive estuarine low lands has tended to either remove these lands from availability or severely curtail their use. There is also concern about open-water dumping because of its potentially adverse effects both on water quality and aquatic organisms.

17. While these physical and social changes have been occurring, changes in the institutional framework have also emerged. These changes are represented in part by the increasing role and regulatory authority of city and county planning commissions. The need to plan for the prudent use of land and water resources is commonly aired at local and regional commission hearings.

18. At the state level, state environmental policy acts, designed to provide remedies to curb pollution of land, air, and water have sprung up in response to the profusion of Federal legislation that forms the foundation of the regulatory pyramid. The wide scope of National Environmental Policy Act (NEPA) applicability together with its limited scope of operative mechanisms burdens the planner to the point where the "closer the better" concept of the site-selection process is simply overwhelmed by today's tremendous magnitude of environmental regulation and legislation. Stimulated by these physical and social changes and the heightened complexity of the institutional framework, extensive project planning, to include the site-selection process, is essential at the Federal, state, and local levels.

Comprehensive Planning Examples that Recognize Producive Uses

19. During this study, two communities--Coos Bay, Oregon, and Rotterdam, The Netherlands--were identified that have prepared long-range dredged material disposal plans that evaluated the long-term opportunities for the productive uses of the disposal sites. These examples represent a level of planning that attempts to do what earlier candidate site-selection processes have done but with the added recognition of the potential productive uses of the created land.

20. Coos Bay and Rotterdam share a common characteristic: the need to maintain access to port facilities having very high community profiles. Consequently, dredging and the need to dispose of dredged material are generally understood and supported by the local community. As a result, dredged material disposal has been carefully coordinated with regulatory, institutional, and long-term community development objectives.

a. Coos Bay, Oregon. The Port of Coos Bay, largest lumber exporting port in the United States, is located on the southwest coast of Oregon. The port is served by a 15-mile-long* channel that has been developed through a rich and scenic estuary. In 1971 the port undertook a long-range dredged material disposal study[2] in response to growing concerns over the loss of valuable tidal flats and the marine life they support. A plan was completed in January, 1972, that proposed 18 sites to provide space for 1,000,000 cu yds of dredged material annually over the next 30 years. A page from this study showing several proposed disposal areas and their suggested ultimate uses is reproduced as Figure 1. One of the criteria used for selecting a site was its redevelopment potential. The study and the process used to select these sites are important because future beneficial land uses were proposed for each site. While the proposed uses were not examined or evaluated in depth, an effort was made to coordinate these prospective uses with the city's comprehensive plan and existing development goals.

b. Rotterdam, The Netherlands. In Rotterdam, where there are strict land use controls and rigid long-term, land use plans, dredged material placement and site development of its Europort area have been carefully coordinated with the planned

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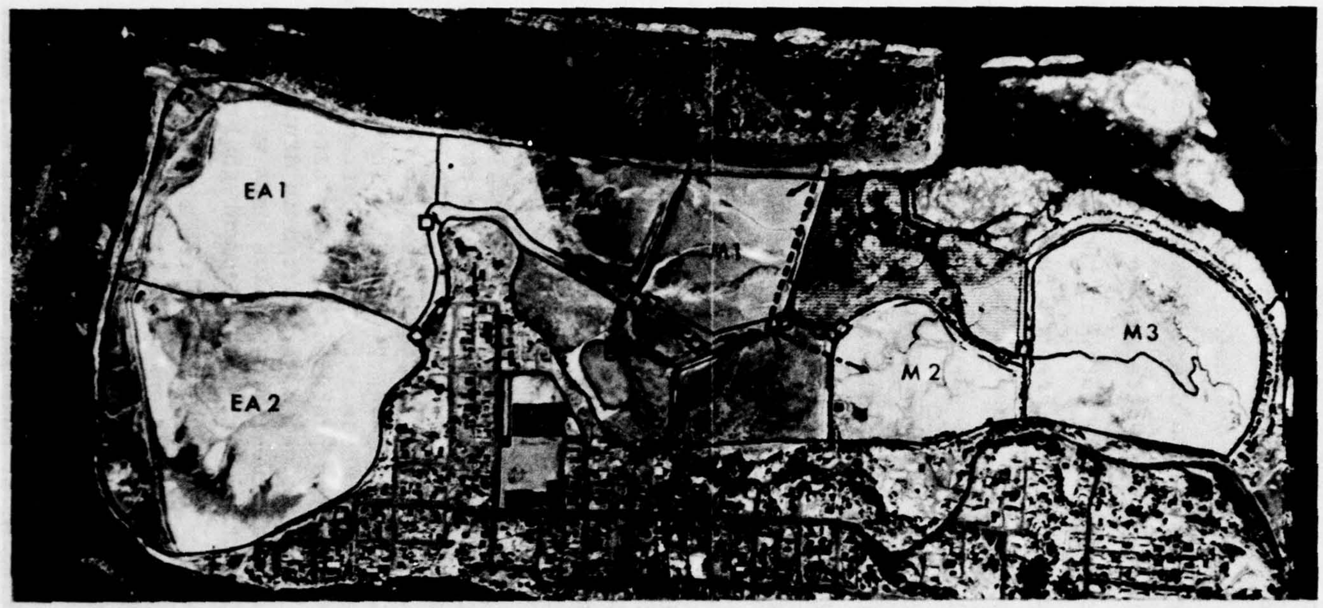
* A table of factors for converting U. S. customary to metric (SI) units of measure can be found on page 4.



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FEET

UNIT	NET AREA, AC.	CAPACITY, C.Y. SHORT RANGE	LONG RANGE
EA1	74.3	550,000	550,000
EA2	61.9	425,000	425,000
EA3	24.8	150,000	150,000
ES1	16.9	225,000	225,000
ES2	16.9	225,000	225,000
M1	25.9	875,000	875,000
M2	22.5	750,000	750,000
M3	49.5	1,675,000	1,675,000

Ultimate Uses: Industrial, Residential, Agricultural

KEY

RETURN FLOW STRUCTURE

RETURN FLOW

RETENTION BASIN

B-W SITE CLASSIFICATION

AREAS 16-17 B & 18-W

EASTSIDE AIRPORT

EASTSIDE SCHOOL

MARSHFIELD

Coos Bay, Oregon

Figure 1. Coos Bay, Oregon, disposal areas that will ultimately be used for industrial, residential, and agricultural purposes.

use designated on its comprehensive plans which conform not only to city plans but also to provincial and national planning guidelines. In April 1976, the Rotterdam Regional Government completed a comprehensive examination of potential future dredged material disposal sites.[3] The selection of sites and disposal of the material in Rotterdam are complicated by the fact that the material is polluted with oil, salt, and toxic heavy metal substances. While pollution is indeed a complicating factor, the community of Rotterdan has recognized the economic need to maintain the Europort in its role as one of the major ports in Europe.

Fifty sites were examined for their suitability for residential, commercial, industrial, and recreational uses. The criteria for site-selection included:

- existing landscape character (scenic beauty)
- biological importance
- maximum pumping distance of 23,000 ft
- minimum of 25 acres in size

The Netherlands maintains short- and long-range development plans for the entire nation. Plans prepared by the national government are developed in more detail by the provinces and developed further by city planning agencies. The dredged material disposal plan completed by the Regional Government in Rotterdam integrates the selection of sites with these land development programs. For example, lands that are planned for residential development in the early 1980's have been identified as potential dredged material disposal areas for use in 1976-1977 (Figure 2). The Rotterdam Plan and Disposal Program is unique because it represents a concerted effort on the part of the institutions involved to carefully integrate the disposal of dredged material into the adopted long-term plans for city and regional land development.

Figure 2. Rotterdam, The Netherlands, city plan. Potential dredged material areas are in black.

PART III: DISPOSAL SITE USE CATEGORIES

21. During the course of this study, 44 sites in 18 states and six foreign countries were identified where beneficial land uses have taken place on dredged material containment areas. Of these, some had numerous land uses taking place concurrently on one site. After analysis of the reported land use, it was decided they would be best described and understood if broken down into categories that demonstrated some similarity. After examination, a method emerged of categorizing the examples based on use and the sites were categorized as follows:

- Recreational
- Industrial/Commercial (includes port development and residential)
- Agricultural (to include horticulture and mariculture)
- Institutional
- Material Transfer
- Waterway Related
- Multiple Purpose

As noted previously, the scope of the study excluded domestic examples of wildlife and fisheries habitat land use of disposal sites. The literature reviewed uncovered no notable examples of such use outside the United States.

22. The projects classified within these seven categories are described below.

Recreational

23. Recreation-oriented uses formed by far the largest number of land-use examples revealed during the study. One possible explanation for this is that people apparently are proud of this land use and its attendant benefit to the community; therefore, there is more of a tendency to report it. Another is that recreation requires a relative minimum of planning and a relatively smaller cost to accomplish. Often recreational use is in conjunction with another use such as wildlife habitat. Recreation is also sometimes a secondary or unplanned use where the primary purpose of the dredged material placement is for

waterway control, bank stabilization,or some other hydraulic control purpose. In addition, the nature of recreation sites with much open space and light construction is especially suited to the weak foundation conditions associated with fine-grained dredged material. Also, recreational land is generally for public use, and high demand for public, water-oriented recreation encourages the development of recreational land use projects. Finally, legislation relating to wetlands, coastal zone management, and flood control is biased in favor of this type of use. The recreational land use of dredged material containment areas is one of the more promising and implementable productive uses of dredged material but is heavily dependent on financial backing at the local level. Examples of cases where recreation is the only planned land use are cited below.

24. Smith's Point Park in Suffolk County, New York, is located on Long Island between Narrow Bay and the Atlantic Ocean. The county owns and operates a hydraulic dredge for the purpose of dredging county-maintained channels and basins and simultaneously creating new marine and park facilities. Smith's Point Park was developed on a 512-acre site during an 800,000-cu-yd maintenance dredging project. The park is 7 ft above bay level and slopes up to a 20-ft elevation on the ocean front. The park includes a clubhouse and a parking lot. This work has been labeled by the county as a "triple-benefit waterfront project" because it simultaneously maintained channels, created new park and marine facilities, and provided useable disposal areas rather than disposing of the material as waste.[4]

25. An example of noncommercial recreation can be found at East Potomac Park in southwest Washington, D.C., astride the confluence of the Anacosta and Potomac Rivers. Disposal operations were completed in 1912, whereby 329 acres was created from fine-grained clays and organic materials dredged from the Potomac main channel. By 1925 the Park reached full recreational development and since 1939, ownership and operation of the facility has been in the hands of the National Park Service (NPS). The site currently offers four 9-hole golf courses, a snack bar, driving range,and clubhouse. Other recreational facilities

include a swimming pool, indoor and outdoor tennis courts, eight baseball fields, as well as fields for field hockey, football, and polo. Buildings on the site include the NPS office, a maintenance building, comfort station, and several other minor structures. Use of the park open space for recreation has increased to the extent that the conversion of a portion of golf course land to open space is being considered. The Park serves a regional need for recreation of residents of the District of Columbia, Arlington County, and the city of Alexandria as well as area commuters. In 1975, the Corps' North Atlantic Division placed the value of the Park at $94 million.

26. The Patriots Point Project is a 450-acre, commercially oriented recreational site immediately across the Cooper River, 1 mile east of Charleston, South Carolina. The site, formerly known as Hog Island, was used for disposal of maintenance and new channel dredged material--primarily mixed sandy silt and clay--from 1956 to 1970; dikes were constructed of heavy clay. In the early 1970's a quasi-state agency, designated the Patriots Point Development Authority, was established to plan and develop a recreational complex. The focal point of the development is a Naval and Maritime Museum with the aircraft carrier Yorktown, moored at the site in early 1976, as the principal attraction. The Authority's Master Plan includes an 18-hole golf course, 150-room motor inn with convention facilities, a 375-slip marina, and a 300-space recreational vehicle park. Long-range plans include construction of an oceanarium, aquatic theatre, amphitheater, restaurant, man-made lakes, and as permanent mooring of at least three more classes of decommissioned naval ships as the vessels become available. A dike-top tour route around the site will also be constructed. The project is forecasted ultimately to attract 1.5 million visitors annually. Structures at the site will be supported on pilings due to the compressible nature of the fine-grained dredged sediments and underlying organic material. An overburden of sand will be added to provide suitable drainage and foundation conditions for light structures and parking areas. Top soil, possibly including some dredged material, will also be placed in portions of the site to encourage vegetative growth, particularly in designated

buffer zones. Figure 3 depicts the Master Plan for Patriots Point.

27. In Portland, Oregon, Kelley Point Park, at the confluence of the Columbia and Willamette Rivers, was created from an old disposal site. Mounds of sand pumped on the site were used as a landscaping feature of the new park. It is primarily a passive recreation area for picnicking and watching marine activities. In Cresent City, California, a recreation area consisting of a park, picnic area, and swimming pool was created in 1965 with silt and sand excavated from a channel dredging project.

28. One example from a number of recreational uses in the Philadelphia area is a site owned by the Corps of Engineers at New Castle County, Delaware. The site was filled with silt and sand between the 1930's and 1971. Recreation facilities are presently under construction and will be transferred to the state upon completion.

29. At Galveston, Texas, an area filled in 1973-1974 with silt and fines has been converted to a golf course owned by the City of Galveston. This land use was planned at the time the site was selected. At Pierre, South Dakota, silt and sand dredged from the Missouri River in 1968-1969 was used to build up and beautify a city park.

30. A multi-faceted, recreation-oriented project was developed in Larkspur, Marin County, California, by the Golden Gate Transportation District. The project called for the dredging of a new channel to accommodate a ferry terminal under construction at the mouth of Corte Madera Creek on San Francisco Bay. The adjacent wetlands were in the intertidal zone and the original plan was to fill them with silt and clay dredged from the channel. But a subsequent plan evolved whereby a bayside section of the site was restored as marshland by breeching the existing dikes. The rest of the project area was raised above tidal level by deposition of the channel dredged sediments, and a wildlife viewing area and a public park for compatible passive recreation were developed. This project is an example of how extensive planning, coordination, and cooperation among numerous local institutional agencies and public-interest groups created a desirable waterfront recreation site.

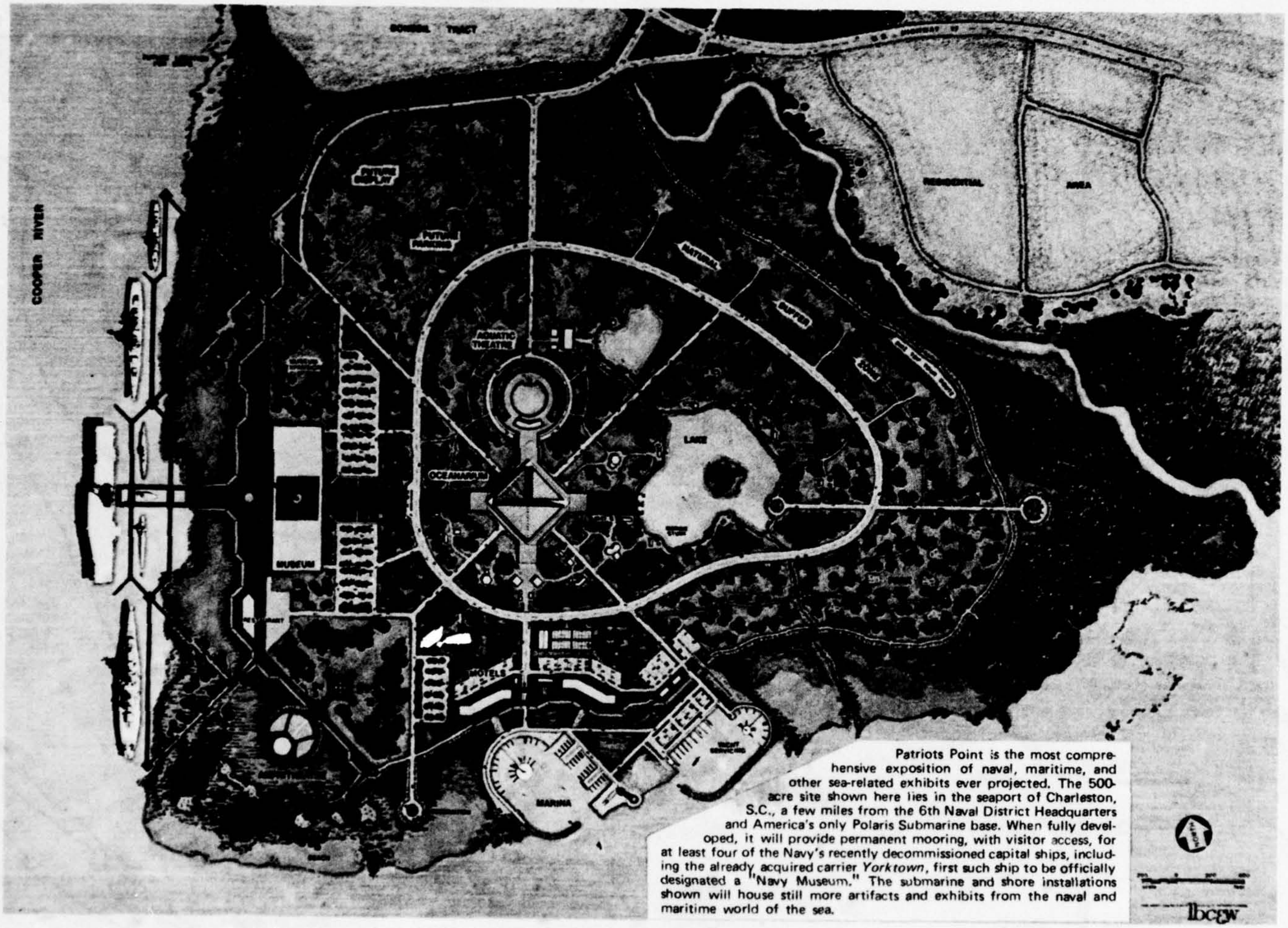

Figure 3. Master plan, Patriots Point Naval and Maritime Museum, Charleston Harbor, S. C.

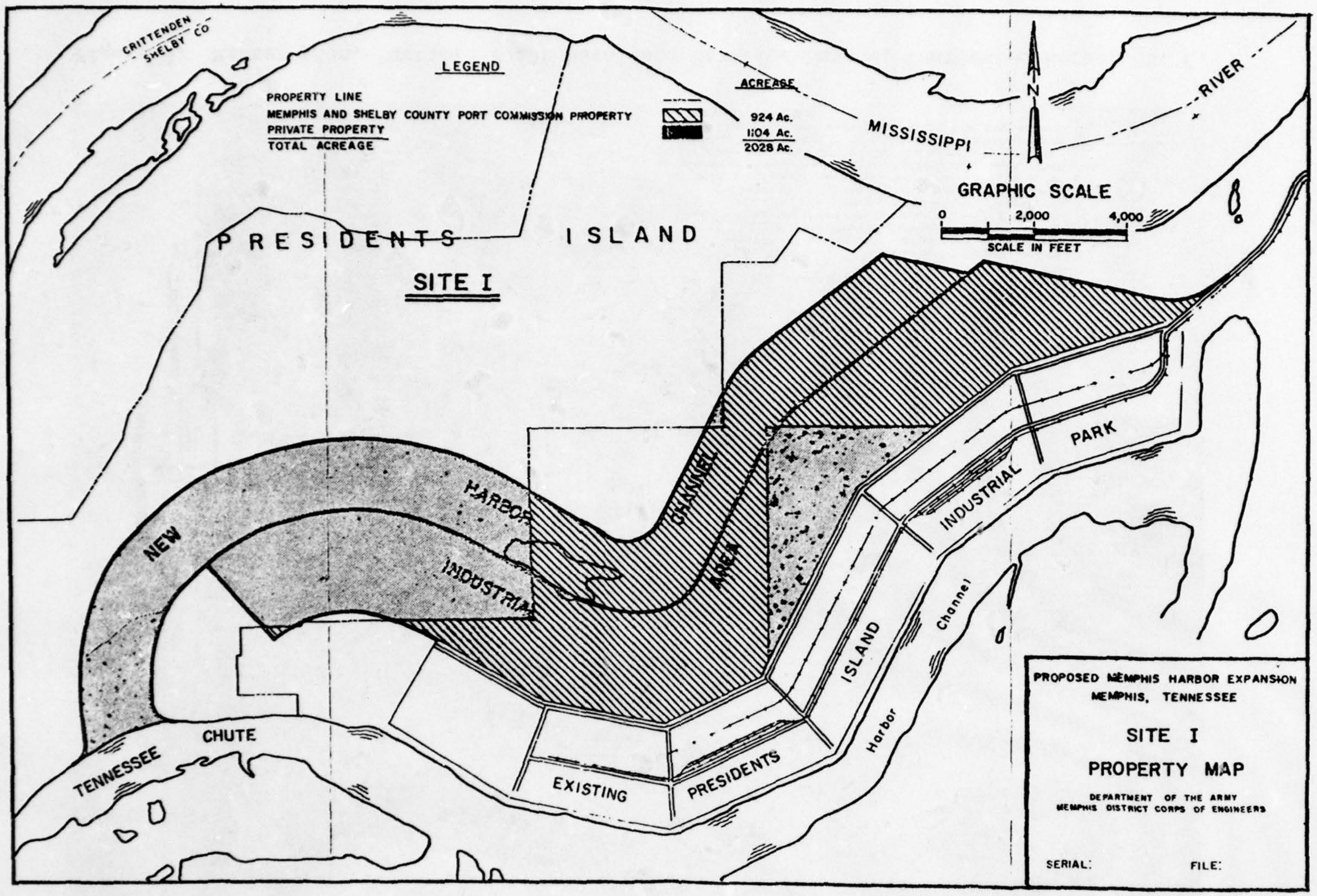

Figure 4. Presidents Island

Industrial/Commercial (Port Development and Residential)

31. The use of disposal areas for industrial/commercial and port-related purposes is so common that no effort was made to document all of the uses found during the investigation. Three river ports where industrial land development from maintenance dredging has been particularly widespread were selected as interesting site use examples.

32. The Presidents Island-Memphis Harbor Project is located approximately 5 miles southwest of Memphis, Tennessee. It is a 960-acre site on the southeast side of the island (now a peninsula) filled with sandy dredged material. A slack-water area was created by diking, and an 800-ft-wide by 12-ft-deep channel was dredged and the sediments placed along 3½ miles of the channel's north bank. Filling was completed in 1957 and within 20 years most industrial development was completed. By 1973 over 70 separate industrial concerns had bought or leased acreage on the site. A feasibility study of proposed harbor expansion alternatives, prepared by the Corps' Memphis District, put forth a recommended plan to dredge a second harbor channel at Presidents Island and place the material on the island along the new channel's south bank. This proposal would create an additional 1000 acres above the floodplain for port and related industrial/commerical facilities (Figure 4).

33. At the Port of Brisbane in Queensland, Australia, extensive dredged material disposal areas have been created since the late 1800's. The materials dredged have been silt and clay. A number of productive uses are being made of the disposal areas including a cement-loading wharf, an oil refinery, light industrial areas, container storage, agricultural export terminals, and cattle grazing. The land areas are so great and the uses so inherently important to the economy of the region that this is considered a particularly significant example of industrial and port use of dredged material disposal sites (Figure 5).

34. Another river port where extensive use has been made of fast-lands is Portland, Oregon, where the port has purchased thousands of acres of land to receive dredged material. An older area in town is later described under the multiple purpose category. A newer area, the

2700-acre Rivergate site, is presently under development about 10 miles from the city center. This area, largely underlain by compressible materials, receives silt from the Willamette River and sand from the Columbia River. A number of port and industrial facilities including a steel mill, a grain terminal, and container yard and warehouse for barge receipt of paper products have been placed on the site (Figure 6).

35. During the course of this study it became apparent that selection of disposal sites for port-related dredging projects has most commonly been accomplished in conjunction with the preparation of port facility master plans. Port planners have long recognized dredged material as a resource out of place and that facility planning can often be coordinated with the planning of new work or maintenance dredging activities. The use of dredged material to ensure provision of disposal areas and enhancement of the port has generally received local approval because the beneficial potential accruing to the local economy is easily recognizable. The ready approval, however, is directed at advancing the implementation of the port development project and not at the incidental need for the proper disposal of the dredged sediments. Traditionally, if the disposal of the material will assist in the end goal of development, there are attempts to use it productively; if it will not, it is generally disposed of by the most economical means available.

36. Other examples of industrial/commerical land use are discussed in the following paragraphs.

37. A major dredging project in Kingston, Jamaica, in the 1960's resulted in 265 acres of land being reclaimed for an industrial and commercial complex.[5] The fill came from excavation of the 35-ft ship channel. Four and one half million cu yds went into the fill and about 3.1 million cu yds were dumped at sea. Surcharges of up to 20 ft were used to preconsolidate the soil. This allowed the warehouses and port transit sheds to be built on spread footings. At the time of development, plans called for residential uses on nearby reclaimed lands and a major program to modernize and beautify the area.

38. A unique combination of port development and housing construction on dredged material was found in the Republic of China. At the

Figure 5. Brisbane River, Australia, showing variety of productive shoreline uses on silty dredged material (right and left middleground).

Figure 6. Rivergate at Portland, Oregon, showing a container terminal on the Columbia River and a grain terminal on the Willamette River.

Port of Kaohsiung, port lands have been constructed from material dredged during the construction of access channels to the port. With the expansion of the port and construction of a second entrance to the port area, large areas were reclaimed with the dredged material. While most of the reclaimed area was devoted to port-related purposes, a parcel of land was devoted to housing for fishermen and their families relocated as a result of the harbor expansion project.

39. Examples of residential use of dredged material disposal sites were found in the United States. In the Bronx area of New York City, a site was created in 1952 from maintenance dredging of the Hutchinson River (also known as East Chester Creek). In spite of the poor quality of the dredged material, which consisted of silt and fines, the site has been developed into a multiple-building, high-rise apartment complex.

40. The dredging of San Rafael Creek at San Rafael, California, on San Francisco Bay, has likewise resulted in the creation of land for extensive housing. The residences are placed on material dredged prior to and during the 1950's. The material is silt and clay, and the area has been developed with low-rise, single-family and multiple-family housing units and attendant neighborhood facilities.

Agricultural

41. In recent years, there has been extensive interest in the potential of disposal of organic wastes on marginal agricultural land with the intent of increasing crop yields. Increased soil fertility is attained by improving the organic content, moisture-retention capacity, textural characteristics, clay mineral distribution, aeration, pH, and other chemical and physical characteristics. Dredged material has been used as a soil amendment, and inactive dredged material containment areas are being used as agriculture land today. A greenhouse study on the agricultural value of dredged material was conducted by the Agricultural Research Service (ARS) for the DMRP.[6] The study results indicate that, under the right conditions, dredged material can be used to improve marginal agricultural land and can, by itself, support forage crop growth. However, the potential for success using dredged material is not only based on technical considerations such as the nature and

extent of impermeable soils and their susceptibility to pollutant uptake, but also to a substantial degree on regional economic conditions and trends.

42. One DMRP study related to this point examined the feasibility of using dredged material containment areas to grow lawn sod or horticultural crops.[7] There were no technical problems that could not be overcome; however, the market conditions governing the sale of lawn sod and horticultural crops limited the opportunity for the application of the concept. Specific market studies dealing with economic feasibility are necessary before instituting agricultural land use concepts.

43. One site currently in agricultural production was identified in South Carolina. The Old Daniel Island Disposal Area in Berkeley County was used for maintenance dredging in Charleston Harbor from 1953 until 1968. Dikes were constructed of heavy clay; material deposited was silts and fines. The Googenheim Foundation has truck farmed 450-500 acres of the 700-acre site for the last 6-8 years. Almost all native crops have been grown successfully with corn and soybeans showing the best yields. In 1977, all acreage was devoted to these two crops with the exception of 15 acres being tested for wheat production. No special crop management techniques have proven necessary. Crops are marketed locally with no indication as to their source; no adverse public opinion has been heard. A second disposal site on the island, initiated in 1968 is nearly to capacity and upon filling will be turned over to the Googenheim Foundation to expand their farming operations.

44. A small experimental crop production experiment was carried out at the Reichold Chemical Company fill in Columbia County, Oregon, in 1973. In this case peas were grown on a disposal site created some years earlier from clean Columbia River sand. Special fertilizers, growing methods, and irrigation were required due to the nature of the material. The crop was successful but commercial feasibility has not been examined further. Another agriculture experiment is being carried out in Mitchell Bay, Ontario, Canada, by Public Works Canada. In this case a small plot of fine-grained material has been cultivated and planted with winter wheat. The purposes of this research are to

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evaluate various types of dikes with respect to their effectiveness in retaining mercury in the dredged material within the enclosure and to evaluate the effect of the mercury on the wheat crop.

45. In addition to these agricultural projects, three uses of dredged material containment areas for livestock grazing have been documented. The Tulsa District since 1973 has been leasing dredged material disposal sites along the Arkansas and Verdigris Rivers to adjacent property owners for use as grazing land. Presently the District has 2600 acres under grazing leases. Natural colonization has provided suitable grassy vegetation for feeding. Leasees have not honored their agreements in that they have allowed cattle to roam on the slopes of the disposal berms along the edges of the rivers. An erosion problem has resulted, so the Corps is in the process of terminating the leases by attrition. Future plans are to artifically propagate the disposal lands where needed to produce a green strip area along the rivers where wildlife habitat and sport fishing uses would be encouraged. *Despite the erosion problems*, grazing projects on dredged material disposal sites have been successful. On the Gulf and Intracoastal Waterway in Jefferson and Galveston Counties, Texas, lands between miles 289 and 349 are used for livestock grazing purposes. The fills are of silt and sand and were initiated in the early 1930's. Some of the areas are still being used for material disposal. A similar use is being made of lands in Pacific County, Washington. Lands were filled from maintenance of the Willipa Harbor channel in 1972. The area is filled with silt, fines, and organic material and is being used for livestock grazing.

46. Under the Products Development portion of the Productive Uses Project, the mariculture of shrimp in a conventional disposal site was a field-tested DMRP concept with apparent potential for at least regional application.[8,9] In a 20-acre portion of an active 158-acre containment area, approximately 700,000 juvenile brown shrimp, sustained exclusively on the nutrient value of dredged sediments from the Gulf Intracoastal Waterway in West Galveston Bay, were grown to a marketable size in about 3 months. Excellent growth and survival rates were

noted and chemical evaluation resulted in an issuance of a National Marine Fisheries certificate of wholesomeness for human consumption. The shrimp were successfully test marketed through wholesale and retail food and bait outlets. In this and similar concepts, the advantage to the Corps is that a landowner is more likely to favorably consider the use of his land as a disposal site if he can derive some benefit from it rather than relegate it solely to a form of waste disposal. In mariculture, the disposal site forms the required impoundment, and the organic-rich dredged material is a periodically renewed source of food for the organisms.

Institutional

47. The institutional category includes all public service/ municipal uses of dredged material containment areas such as electric utilities, transportation systems, and water and wastewater facilities.

48. Pleasure Island bordering the Intracoastal Waterway near Port Authur, Texas, is a 3500-acre land area formed from over 50 years of silt and sand disposal. A rock dike protects a small portion of the island that is presently developed. Among the diverse facilities developed thereon are a university campus (Lamar University), an Army Reserve Training Center, and a Corps Area Office. Two recently constructed rock dikes will encourage further institutional facilities including an already planned sewage treatment plant.

49. In Salem County, New Jersey, a 1967 land swap negotiated between the Corps and the local public utility company has resulted in the construction of a nuclear power plant on a 200-acre disposal site. The first four units commenced operation in 1976, the remaining units will be on-line by 1979 and mid-1980. The site was originally a sand bar upon which fine-grained material from Delaware River dredging over the past 70 years had been placed to form a peninsula--now called Artificial Island.

50. The Corps of Engineers has filled to capacity a series of disposal sites along the Chesapeake and Delaware (C & D) Canal during maintenance of the 35- by 450-ft channel. The material was silt and sand and no land use was planned at the time the filling was started

in the 1970's. One such site is being used as an experimental test plot for the disposal of severage sludge. Most of the disposal sites are unvegetated so in addition to providing a means of disposal, placement of the sludge with its attendant high nutrient value will stimulate vegetative cover. The project is still under study for identification of possible adverse effects.

51. In Yolo County, California, on the Sacramento River, sand from maintenance dredging of the river was placed in a fill that was used as a site for the California Highway Patrol Academy. The dredging work was done in 1972.

Material Transfer

52. In recent years great attention has been given to the reuse of recycling of materials. The same attention has been given to the reuse of dredged material, particularly as it relates to the opportunities for reusing containment areas after previously deposited material has been removed. Disposal Area Reuse is dealt with separately in detail elsewhere in the DMRP under the Disposal Operations Project.10 During the course of this study a number of sites were identified where the dredged material has been transferred from the disposal site for a productive use elsewhere.

53. In Philadelphia the Corps of Engineers has a material transfer program with several facets. In some cases, native material in the disposal area has been sold. This increases the volume available to accept dredged material and lowers the cost of retention dikes necessary to retain the material. Also, in some cases, the dredged material has been removed from the disposal area and sold for use in the surrounding community.

54. On the Fraser River near the city of Vancouver, British Columbia, materials are placed on land and moved off the site for use in nearby construction projects. This use has been in effect for a number of years and is enhanced in that the material is sand.

55. In London, England, material from a containment area that was filled in the 1960's is now being removed and used as a cover material for a solid waste disposal area. The material is silt and clay from the

Thames river.[11] In Solano County, California, approximately 11 million cu yds has been removed from several Corps of Engineers disposal areas that were nearly filled to capacity. The material has been loaded on barges and towed approximately 60 miles to Stockton, California, for use as embankment fill for the Interstate 5 freeway. In this case the material is clean sand that meets interstate highway specifications.

Waterway Related

56. During the investigation it was found that dredged material is often used for purposes closely related to the maintenance, preservation, and expanded use of waterways and the surrounding lands. These functions are classified under the heading of waterway related use.* The use of material for waterway related purposes (shore protection, beach nourishment, breakwaters, river control, etc.) is consistent with the Corps' planning and executing authority for waterways. Successful implementation of such uses of dredged material are greatly influenced by the method and sequence of the dredging operation as well as the layout of the disposal area. Waterway related use normally involves the creation of landforms and thus permits opportunities for imaginative multiple use site development. These landforms commonly result in a secondary recreational use.

57. After studying the following examples it will be obvious that nearly all of the waterway-related uses incorporated dredged material of a sufficiently high quality which allowed it to be pumped in place and to provide some structural characteristics to withstand the eroding forces of waves, wind, and currents. These cases show where planners were able to take advantage of the characteristics of the dredged material and the geography of the area to provide a highly productive land resource.

58. These examples are cited with the qualification that they are not instances where the productive use was developed by dredging selected material for the prime purpose of creating the landform. But

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* A term coined by the authors of "Dredged Material: Natural Resource or National Nuisance."

in fact, the need to accomplish a specific dredging project created a need to dispose of the dredged sediments and the disposal option excised was planned with the intention of creating a productive use of the resultant landform.

59. In Duval County, Florida, sand dredged during maintenance of the St. Johns River entrance to the Port of Jacksonville, Florida, has been used for the restoration of an eroding beach. The beach serves as protection to upland properties and is also used for recreational purposes. Beach use requires a particular set of circumstances that are related to the distance between the dredging site and the eroding beach and are dependent on the quality of the dredged material. The material to be dredged has to be clean sand and should reasonably match existing beach material in grain size and color. In some cases beach nourishment projects are a Federal responsibility and in others a local responsibility. The dredging work serves the multiple public purposes of maintaining navigation, protecting uplands, and restoring beaches. There are numerous cases of the use of dredged material for beach restoration in Florida and in California.

60. In Monroe County, Michigan, silt and clay from the mouth of the Detroit River at Lake Erie have been used to create a barrier dike to protect and possibly assist in restoration of an extensive marshland area. The island thus created can be used for recreation after filling is completed.

61. Along the Columbia River in Oregon and Washington, sand dredged from a navigation project has been used extensively for river control projects. The primary use is to place the material along existing banks to confine the flow of the river and thus assist in channel maintenance. The material thus placed also creates an excellent recreation area for use of swimmers, fishermen, and picnickers.[13]

62. Examination of disposal area plans show a tendency toward repetition of square and rectangular areas or the squaring-off of an existing indentation in the shoreline. Often the reason for this is the desire to minimize the diking costs or to maximize the use of a site by filling to the property boundaries. Where these conventional

shapes have been abandoned and unique landforms have been attempted, opportunities for new uses have been created.

63. For a channel dredging project in San Diego, California, instead of making a conventional rectangular fill area along the existing shoreline, the sand, shell, and silt fill has been laid out to form the protective outer breakwater for a marina (Figure 7). The breakwater is sufficiently wide to be used as a park fronting on both the marina and the bay. The landform itself will significantly contribute to the quality of the use of the land.

64. A similar example can be found along the Columbia River navigational channel at Kalama, Washington, where sandy dredged material has historically been pumped along the shoreline to constrict the river, protect the banks and provide informal recreation areas. Hydraulic model studies of the Kalama area indicated that channel maintenance dredging could be reduced by a substantial reduction in the width of the river. Under conventional practices, this would have been accomplished by permeable groins being placed at right angles to the river and dredged material being pumped between the groins. It was recognized that the same objective could be accomplished by placing the sand in the shape of a "L" with the short leg at right angles to the shoreline and the long leg heading downstream, parallel to the existing beach. The land thus created would have water on all sides, but, more importantly, the 10-acre water area between the "L" and the existing beach would provide a harbor for launching and moorage of small craft. This water area would be protected from river currents, wind, waves, and wakes from passing deeper draft vessels. A park has been constructed at the upstream end of the fill and a launching ramp at the outer end of the "L". Initial construction of a marina was completed in 1977. The costs of the dredging and river control structures were comparable to a conventional design with the added benefit of the local community gaining a ready-made small boat harbor essentially at no additional cost (Figure 8).

65. A sand breakwater has been constructed at Saldanha Bay, South Africa, using dredged material.[14] The breakwater is part of the Sishen-Saldanha Bay project, which includes a railway line from the

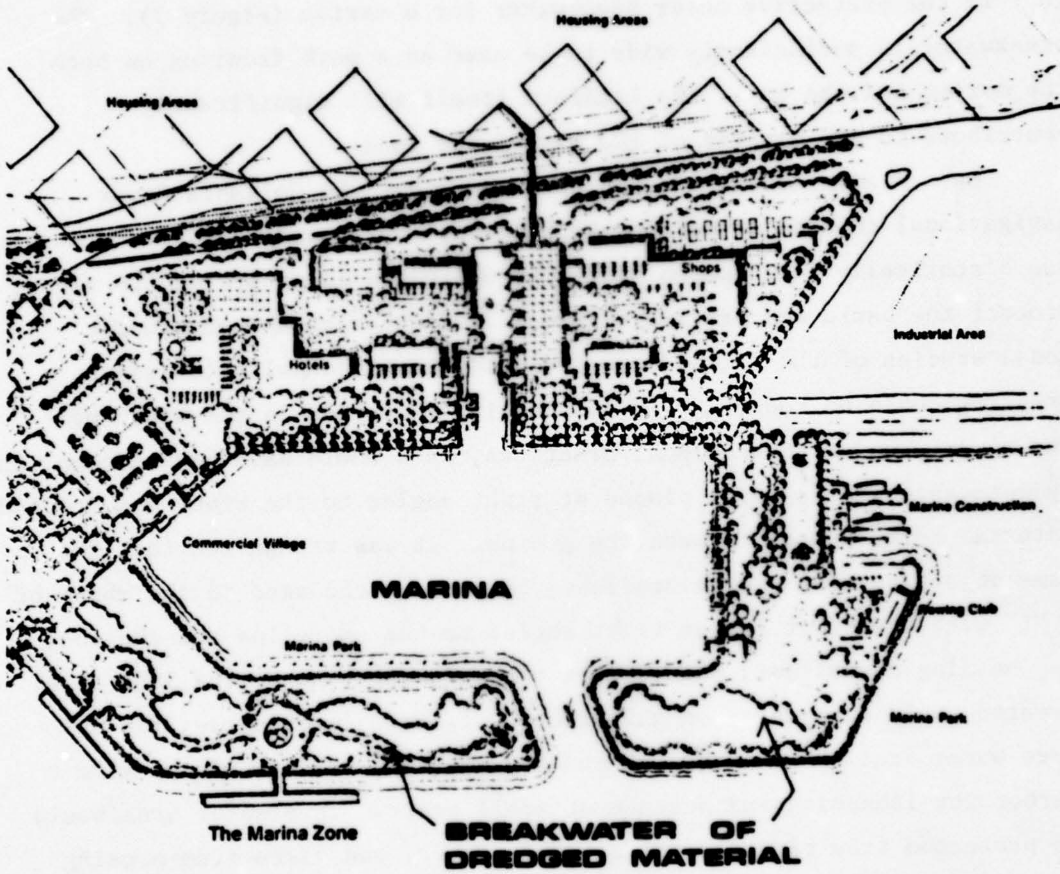

Figure 7. Plan view of San Diego, California, marina showing expanded breakwater of dredged material.

Figure 8. Recreational Area, Columbia River, Kalawa, Washington

Sishen iron ore mines and an ore export port at Saldanha Bay. The sand breakwater was selected over a conventional rock or concrete structure after extensive testing of wind and wave characteristics in the bay. The breakwater will provide protection for the proposed port facilities as it connects the mainland with an existing offshore island (Figure 9).

66. Other examples of waterway related uses of dredged material and adjunct recreational use can be found along the Arkansas River, in Little Rock and Yell County, Arkansas, along the Big Sandy in Kenora, West Virginia, and in Higgins Port, Ohio at the Oak Creek Public Access Area adjacent to the Ohio River.

Multiple Purpose

67. The conventional approach to site development and subsequent use of the disposal areas is to consider the material dredged as a constraint on development or use of the site. For instance, disposal areas filled with silt and clay can be expected to offer poorer foundations and have settlement problems. Several projects were identified where careful planning and material placement enabled the developer to largely overcome the inherent problems of the dredged sediments or the site. The following Toronto and Portland examples demonstrate what can be accomplished when poor grade dredged material is placed in conjunction with higher quality materials to produce a more usable site.

68. Along the shoreline in Toronto, Canada, numerous commercial, transportation, and recreational sites have been created by the combined use of land fill and dredged material. Aquatic Park, under development by the Toronto Harbour Commissioners, is an excellent example of where the form of the land created can enhance the number and quality of productive uses. Construction rubble was used to create an approximately 3-mile-long headland running at an oblique angle to the natural shoreline. The headland is essentially linear but has numerous indentations in its shoreline dike. Dredged material was placed in the water behind the rubble dike where protection is afforded from wave and tidal action and associated erosion. The dredged material was placed to form contours for the development of lagoons and lakes along and behind the shoreline. The resultant configuration of the headland resembles natural landforms

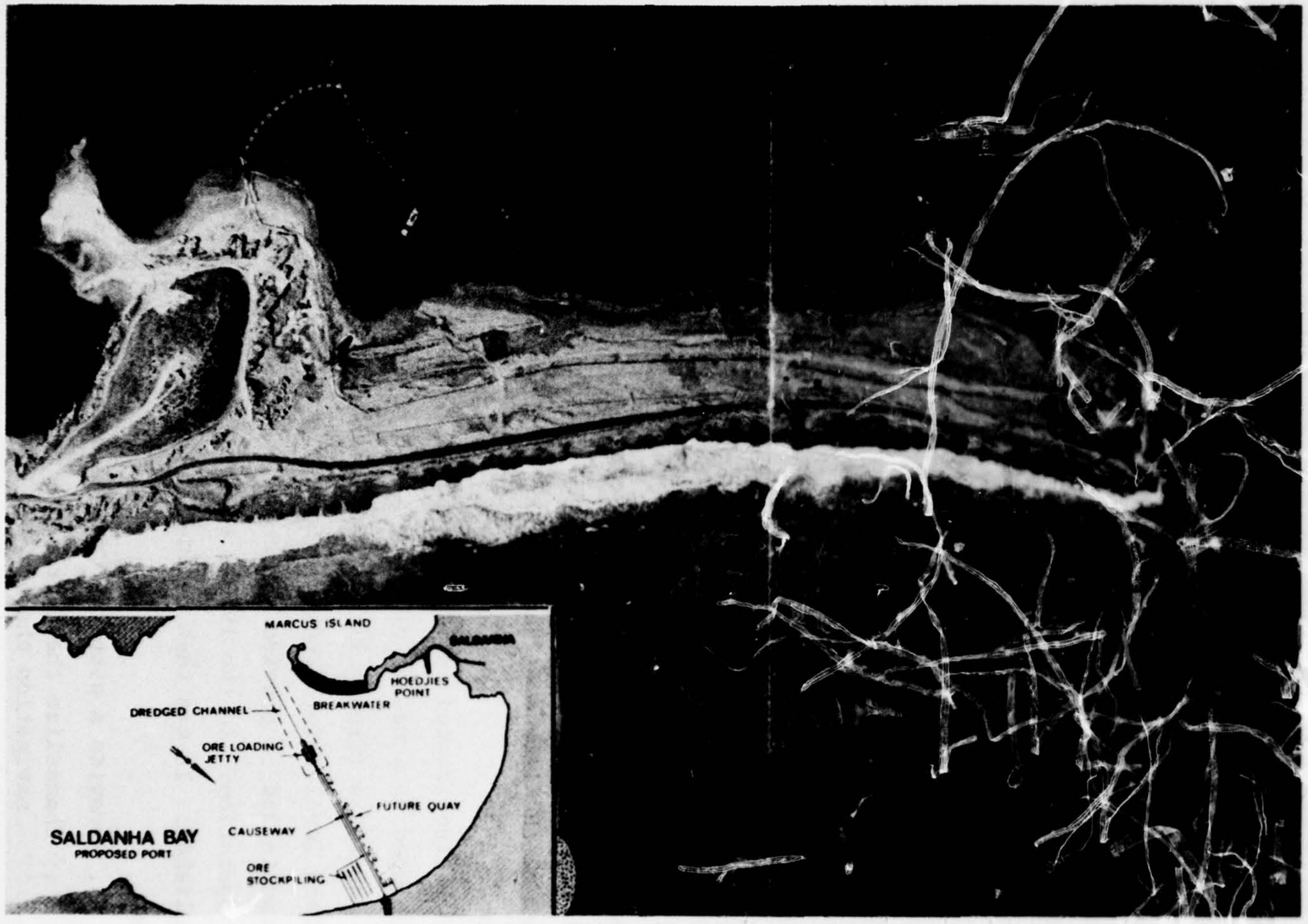

Figure 9. A 26-million-cubic-yard sand breakwater under construction at Saldahna Bay, South Africa. Insert shows location in the harbor.

in the area. The length of shoreline is many times the length that would have resulted from a conventionally shaped disposal area and thus opportunities for shoreline utilization were increased. Figure 10 shows Aquatic Park during dredged material placement.

69. During the 1920's, a massive dredging project was carried out to realign the Willamette River in Portland Harbor. Several major land fills were created from the silt and sandy dredged material. On the west bank of the river, a massive land fill resulted in a large area of primarily industrial land known today as Guilds Lake Industrial Area. This area is privately owned and has evolved into a multiple-use transportation and modern industrial center. It is the center of highest employment in the City of Portland. On the east bank, an existing island, Swan Island, was raised above flood level and connected to east Portland by means of a causeway constructed with dredged material. Swan Island had no planned function beyond being a dredged material disposal site but in the 1930's the island was converted into Portland's first airport. The airport was subsequently moved to another site in 1939 and most of Swan Island was devoted to a shipyard for the construction of tankers and freighters during World War II. After the war the shipbuilding facilities were converted to a ship repair yard, a use which continues today. The remainder of the island is still under development as a planned industrial park.

70. Also located on Swan Island is "Port Center," a commerical site developed as a result of the planned placement and sequence of dredged materials (Figure 11). At the time the island was raised above flood level using dredged material, a notch was left at the upper end of the island to provide an access channel to a grain export facility then in operation. In the 1960's the grain facility became obsolete and was demolished. It was then decided to fill the notch to serve three purposes:

- provide a site for dredged material disposal
- channelize the current to reduce shoaling in the navigation channel
- provide a site for commercial development

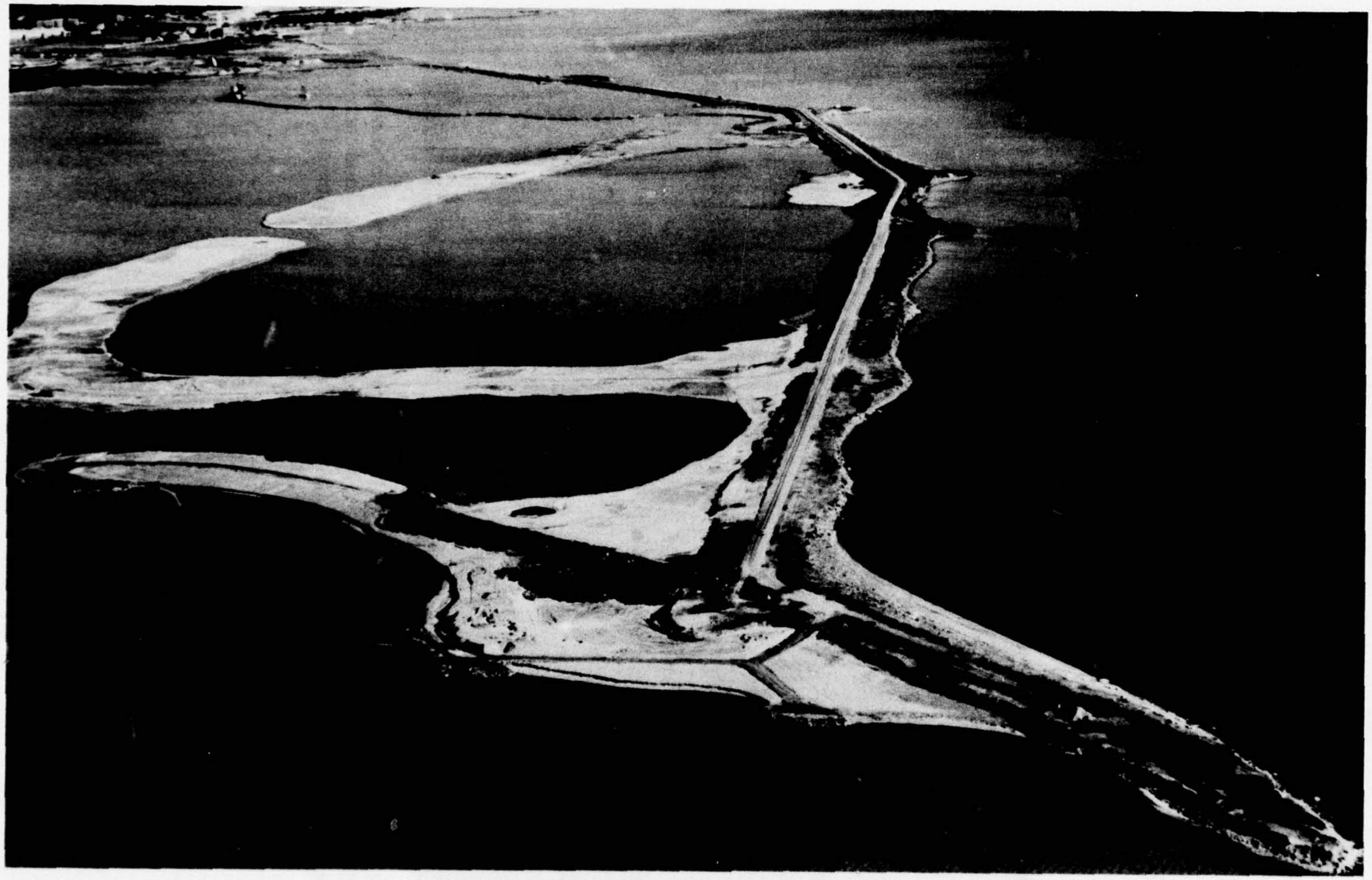

Figure 10. Headland and dredged fill under construction at the site of Aquatic Park, Toronto, Canada.

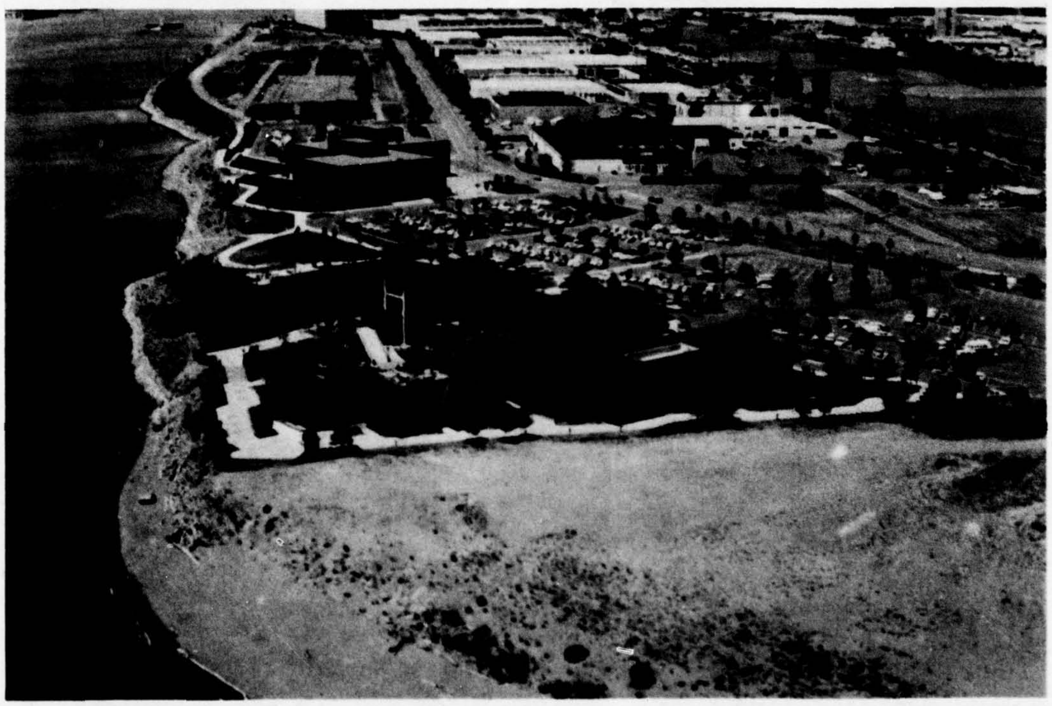

Figure 11. Port Center at Swan Island, Portland, Oregon, showing building development that was located on the better materials and the parking areas located on the softer material. Vacant area is planned for commercial and low-rise office building.

71. The dredged material consisted mostly of silt and clay and some sand. The sand was deposited along the outer edge of the notch-fill area to provide an enclosed dike. The softer silt and clay were pumped into the enclosed area and the solids were allowed to settle out. Some of the sandy dredging locations were not worked until the end of the fill operation so that the top 5 ft of fill would be composed of the coarser, more stable material placement of the commercial structures. The softer, less stable material was placed to coincide with parking and landscaped areas. The resulting land uses, e.g., restaurants, various commercial enterprises, and a low-rise office building, were possible because of the sequencing of the fill. A substantial amount of planning and site exploration was required to carefully manage the dredging and filling operation and to identify the location of the granular material.

72. The North Channel in Grays Harbor at Hoquaim, Washington, provides access between the Pacific Ocean and the export docks at the Port of Grays Harbor. From maintenance dredging of the channel beginning in the early 1930's, a dredged fill was accumulated that is not over 2 miles long and 500 ft in width. The material is a mixture of sand and silt. Presently there is a variety of uses on the site including a municipally owned airport, a sewage lagoon, and a privately owned sawmill. This site was particularly suitable for the airport and sewage lagoon because there is a scarcity of flat land in the area. Although these land uses are well established today, they were not a part of the original project planning when the fill operation began.

73. Multiple land use experience has taken place at Galveston Bay, Texas, where large areas were set aside for receiving dredged material in the late 1800's and are still in use for that purpose. These disposal areas were created with maintenance dredging of silt, clay, and sand, and no other use was planned when dredging and filling operations were initiated. Today one such area known as Pelican Island, located on the Galveston Ship Channel, northeast of the City of Galveston, contains recreation areas, port terminals, manufacturing uses, commercial offices, a shipyard, and a college.

74. The use of a site at Beaufort Island, Morehead City, North

Carolina, for disposal of dredged material was initiated in 1935 and completed in 1950. The dredged material was silt and sand, and the dredging was performed for channel deepening and maintenance. At the present time, the property is in the hands of 22 owners including the state of North Carolina. Uses on the site are a state recreation park, warehousing, port-related terminals and storage areas, single family housing, retail and office space, and military facilities including a Navy LST ramp and a Marine embarkation area.

PART IV: FINDINGS AND ANALYSIS

Planning Conditions and Actions Affecting Productive Land Use

75. After reviewing the previous citations, it can be fairly concluded that nearly any productive use is possible provided such use is considered during the site development planning stage. This general statement is supported in a paper entitled, "Sample Approaches to Optimum Use of Marginal Lands."[15]

> Marginal lands....may be reclaimed and used as residential, commercial, and industrial sites. In deciding which of the available methods will result in the optimum use of any site under consideration, the designer must understand thoroughly the requirements of the proposed structures and facilities, the functions they will be asked to perform, and the gravity of the consequences of inadequacy.
>
> With proper planning and understanding, marginal lands may be put to use in accordance with the needs and requirements of the proposed structures by means of an adequate and safe design at minimum cost. In this manner, urgent land needs may be met successfully.

76. To better understand the importance of predetermining the site use, it is necessary to understand the major planning conditions that affect the productive use of dredged material disposal sites. Seven have been identified as follows:

- Characteristics of the dredged sediments.
- Time required to dewater and densify the material.
- Structural foundation ability to support development.
- Inventory of pollutants.
- Institutional constraints.
- Environmental regulatory and legislative constraints.
- Economic factors.

As the sponsor's development objectives become more elaborate, there is an increasing need to recognize those that deal with these seven conditions which in part determine land use. This recognition necessitates the need

to plan, coordinate, and creatively engineer dredged material disposal sites. The Aquatic Park, in Toronto, represents one of the best examples of the creative utilization of dredged material and construction fill to provide a valuable community amenity, in a manner compatible with existing landforms and harbor and waterfront uses.

77. At the other extreme, allowing a disposal site filled to capacity to lie fallow will result in little vegetative recovery and limited wildlife useage for feeding and nesting. But for each additional action undetaken by the owner, developer, or project sponsor, the opportunity for higher orders of site use can be enhanced. Some identifiable planning actions that should be considered are:

- Engineering planning, management, and coordination.
- Dredged material analysis.
- Local land use and zoning coordination.
- Federal, state, or local agency coordination.
- Public and private sector involvement.
- Economic and technical feasibility analysis.
- Funding availability.

While few or none of these additional actions are required for the most rudimentary wildlife habitat, it should be obvious that both the number of planning actions required and the time consumed to achieve them increase as the degree of land use intensity increases. Increased understanding of the relationship between use intensity and the enumerated planning conditions and actions can enhance the implementation of dredging and dredged material disposal site development projects.

Contrasts in Foreign and Domestic Disposal Planning

78. Generally, maintenance dredging and upland disposal are characteristic of industrialized nations. Where dredging is required for channel or harbor construction and maintenance in developing countries, the material is often placed on the nearest available land as was done in past years in the United States. The complexity of environmental, regulatory, and institutional conditions in foreign

countries with active dredging programs varies widely. In some cases disposal planning associated with offshore dumping and channel maintenance takes on international political implications where countries share common borders along contiguous bodies of water. Additionally, in intensively populated and highly developed countries, the land resources are carefully planned and regulated. This requires that dredging operations and dredged material disposal be carefully coordinated with city, provincial, and often national planning programs. The Netherlands again presents the best example of such regional coordination. The United States has its own version of a complex list of environmental, regulatory, and institutional factors to be resolved for each dredged disposal project. The Federal government has clearly defined its interest and authority in the continued maintenance of navigable waterways, ports, and harbors; the control of water pollution; and the protection of fish and wildlife habitats. But, unlike The Netherlands, it has exercised no regulatory authority nor has it defined national areas of interest in the matter of land use planning. The void, resulting from lack of a national program of land use planning, has been filled traditionally by regulatory authorities, exercised by state and local government, to plan, zone, and develop its lands. But recognition of the problem related to dredged material disposal on land and its potential conflict with local planning is not a North American phenomenon. Mr. K. J. Langdon in his paper entitled "Use of Maintenance Dredgings for Land Reclamation Purposes,"[16] stated that for the coordination of dredging, fill, and reclamation activities in England:

> "Each authority has its own terms of reference, and accordingly, probably quite different objectives. This, unfortunately, causes them to act independently each one pursuing its own most profitable line without reference to overall local or even national interest."

79. In communities such as Coos Bay, where there has been public interest in and support of navigation and maintenance of channels because of their economic impact on the community, interagency coordination has been central to the successful planning and integration of differing objectives. However, in most cases, similar concerns in other

communities have been left to the purview of the port authority which has little land use regulatory responsibility or interest outside its boundaries.

PART V: CONCLUSIONS

80. There is not a significant amount of literature on the productive land use of dredged material containment areas. The published literature does not reflect the variety and number of uses taking place in the United States and abroad. Further, it does not provide substantive guidance in the planning, engineering, and dredging practices required to attain productive uses of dredged material disposal sites. Most literature on dredging is focused on the mechanical aspects of the equipment or the biological and water-quality impacts of the disposal operation.

81. Dredged material containment areas can support almost any land use if the planning, engineering, and project execution are performed with the end use in mind. However, achievement of productive land uses with dredged material is a complex problem often requiring skills and costs not required by former disposal techniques. Previous methods minimized planning and dredging costs by utilizing available nearby areas or open water. In present day terms, to achieve the objective of productive uses, a greater level of planning, engineering, and coordination is required. The more complex the final land use, the more sophisticated the planning, engineering, coordination, and execution of dredging must become.

82. Recognition of the importance of integrating dredged material disposal planning with a community planning and land improvement program is essential to the development of beneficial uses of dredged material disposal sites. In the latter part of 1976 the cities and ports of Newport and Toledo, Oregon, and surrounding Lincoln County began the formulation of comprehensive plans to integrate long-term dredged material disposal planning with comprehensive community land use planning. This ongoing effort represents an excellent example of the recognition of dredged material as a resource to enable the development, over time, of land uses most beneficial to the community.

83. One aspect of the complexity of achieving productive uses is the division of responsibility between Federal, state, and local governments for navigation, environmental protection, and land use. Productive

land uses will probably take place where there is a coincidence of Federal, state, and local interests. However, because of the differing vested interests and responsibilities of the various levels of governments, what is productive or beneficial to one may not be to another. One method of resolving this problem is through multi-objective land use planning. Communities that undertake land use planning on a comprehensive multi-objective basis, with multi-agency input and coordination, and concurrently include dredged material disposal in the planning process are more likely to successfully accomplish their dredging projects with associated beneficial uses of the dredged material and/or the disposal sites.

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APPENDIX A: INFORMATION SOURCES

<u>U. S. Army Engineer District Offices:</u>

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Huntington, West Virginia:	Russel Patterson Navigation Section, Operations Division
Jacksonville, Florida:	Moray Harrell Environmental Quality Section Engineering Division
Little Rock, Arkansas:	Jack Woolfolk Design Branch, Engineering Division
Los Angeles, California:	Thomas Bertin Engineering Coastal Research Branch
Memphis, Tennessee:	Gerald Davis Navigation Branch
Mobile, Alabama:	Ed Wallace Project Operations
New York, New York:	Thomas Clark Navigation Branch, Operations Division
Omaha, Nebraska:	Allen E. Mason Plant Branch, Operations Division

Philadelphia, Pennsylvania:	H. Ronald Kreh Construction-Operations Division
Portland, Oregon:	Greg Hartman Navigation Branch
Sacramento, California:	James McBride Construction-Operations Division
San Francisco, California:	William Dickson Operations Branch
Seattle, Washington:	Donald W. Thuring Navigation and Flood Control Branch
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United States. Waterways Experiment Station, Vicksburg, Miss.
Land use of dredged material containment area: productive use examples / by Environmental Laboratory, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Miss., and Ogden Beeman, Al P. Benkendorf, Beeman/Benkendorf, Portland, Oregon. Vicksburg, Miss. : U. S. Waterways Experiment Station ; Springfield, Va. : available from National Technical Information Service, 1978.
49, 4 p. : ill. ; 27 cm. (Miscellaneous paper - U. S. Army Engineer Waterways Experiment Station ; D-78-4)
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